about them. His personal interest in his students was greatly appreciated, and he was universally well liked by them.

The writer became acquainted with Mr. Hankinson while he was a student at the Michigan Agricultural College in 1897. We were both elected Associate Editors of the *Bulletin of the Michigan Ornithological Club,* where in Volume 1, Number 1, pages 1-4, was published his paper on "Progress of Ornithology in Michigan", a very complete outline of the work that had been accomplished up to 1897, giving the names, dates, and lists published by the early ornithologists of the state. While other interests occupied most of his time, he has always been greatly interested in birds, and he has furnished the Museum of Zoology with valuable data and some study specimens, all of which are here gratefully acknowledged. We deeply regret the loss of a valued friend and co-worker of many years standing.

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FREQUENCY OF OCCURRENCE OF SUMMER BIRDS IN NORTHERN MICHIGAN

BY JEAN M. LINSDALE

Twice I have given detailed accounts of a procedure for determining and describing the frequency of occurrence of birds on restricted areas. (See *Condor*, Vol. 30, 1928, pp. 180-184, and Vol. 34, 1932, pp. 221-226). The method has been worked out for studies of plants, but its application to birds is so simple, and the records needed for its use are so nearly the same as those ordinarily kept by bird watchers, that it deserves more attention from bird students than it has received.

The materials used here are the result of fifty days' work in the field in the vicinity of Douglas Lake, Cheboygan County, Michigan, in the summer of 1924. The first work was done on June 9 and the last on August 17. During the first three weeks only a part of each day was spent in the field, but in the latter part of the season whole days are represented in the records. Special attention was given to the nesting birds and their local distribution. During the summer 106 kinds of birds were found; a few of these were early migrants. Because many accounts of the environment in this vicinity have been given by other workers and because a detailed analysis of the birds of the region has been prepared by Professor F. N. Blanchard (MS.), I intend to discuss only the single topic, frequency of occurrence of the summer birds.

For the kind of analysis attempted here more records are desirable than are available, but I believe that the ranking of the species would not be changed greatly by additional material. It would be useful in studying populations of birds to have comparable determinations of relative frequency of occurrence of the species from many localities. In this country hundreds of persons have kept records of the birds observed by them each in a restricted locality. With very little effort these records could be analyzed and concise summaries of them from the point of view of the Raunkiaer law of frequence prepared and published. Some of the refinements of method suggested by Dice (*Auk*, Vol. 47, 1930, pp. 22-24) would add considerably to the value of such results; but with most observers it probably is not practicable to apply them, or at least they have not been applied in the records already made.

Raunkiaer derived what he called the Law of Frequence from eleven pieces of botanical work carried on by himself and others in different parts of Europe. In nearly all such surveys it is learned that there are many more species of low frequence than of high frequence. A curve expressing the numbers in the different classes of frequence has two peaks, a high one expressing the least frequence, and a lower one expressing the greatest frequence. If the species of frequences of respectively 1-20 per cent, 21-40 per cent, 41-60 per cent, 61-80 per cent, and 81-100 per cent are grouped into classes designated as A, B, C, D, and E, the law of frequence might be expressed $A>B>C>$, equal to, or $<D<E$ (Kenoyer, Ecology, Vol. 8, 1927, p. 343).

To avoid duplication of matter contained in previous discussions, I will repeat only a few points which deserve special emphasis. The importance of studies of bird populations and the difficulties encountered in making them are commonly recognized. Adaptations of methods developed in connection with the Raunkiaer law of frequence offer suitable means of analysis of frequency in birds. For this purpose the lists of birds customarily kept by bird watchers provide sufficient materials if they pertain to a single limited locality or single type of habitat. Days appear to be suitable units for observational records, thus shifting the basis for analysis to units of time rather than of space. As to the number of units, this may vary considerably depending upon such factors as size and uniformity of the area and seasonal distribution of the time: but I suspect that, where possible, it is best to have records for one hundred days or more and extending throughout the annual cycle. The percentage of frequency for each species is obtained simply by dividing the number of days on which the species was observed by the total number of days on which observations were made.

Besides furnishing an opportunity for application of the method of frequency analysis to a new locality these records can be compared with another set of figures intended to show the relative numbers of summer birds in the same vicinity. J. S. Compton (Wilson Bulletin,

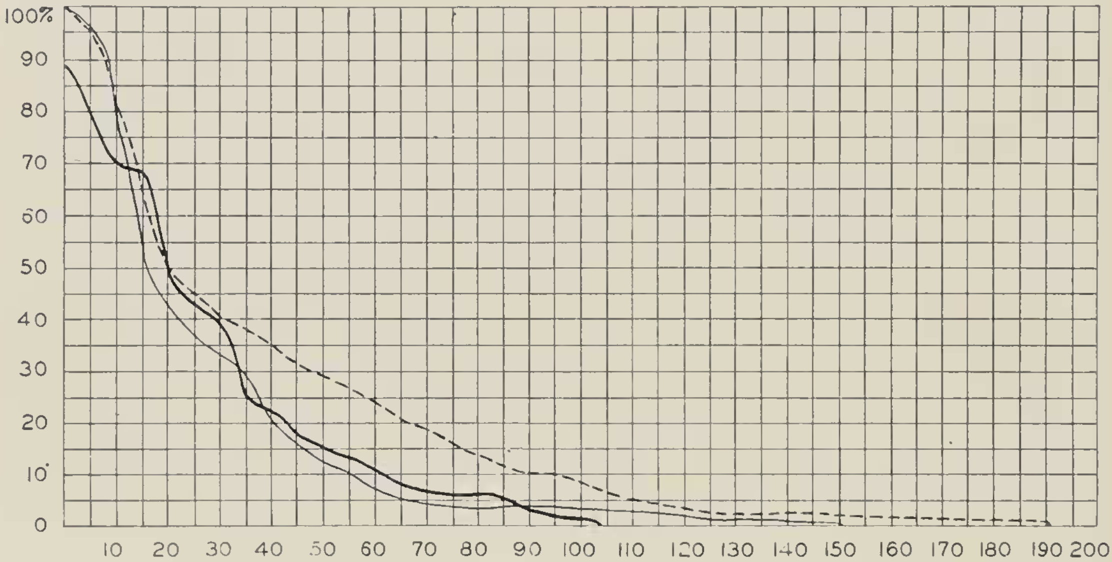

Fig. 29. Graph showing relative frequency of occurrence of the species of birds recorded in three localities: Doniphan County, Kansas (dotted line); Yosemite Valley, California (light, solid line); Cheboygan County, Michigan (heavy, solid line). Each curve represents the percentages of frequence for all the species in a single locality. For example, the heavy, solid line shows how the percentages for the 103 species recorded in Michigan are arranged between the extremes of 88 and 2. On this graph most frequent species are indicated on the left and least frequent ones toward the right.

Vol. 26, 1914, pp. 173-180) observed birds in this vicinity during the summer of 1913 and 1914. He used the term frequency to express the "comparative frequency with which the species, not the individual, was seen." In this connection he used three degrees as follows: "r or rare=seen 1 to 4 times; c or common=seen from 5 to 20 times; a or abundant=seen more than 20 times." He explained that "abundance, on the other hand, applies to the total number of individuals of the different speeics seen during a given period; in this case the period covers from June 30 to August 7, stopping before the fall migration gets any headway to disturb our study of midsummer birds. (1) under abundance means that this species stands highest in number of individual birds seen, 227 in our study; at the other end of the scale of abundance (47) means that only 1 bird of this species was identified."

Compton's determinations of frequency and abundance have been placed in the following table (second and third eolumns) along with my own figures expressing percentage of frequeney (first column) aceording to the Raunkiaer law. Beeause the reeords were made by two separate persons, in different years, and with different objectives the results are not exaetly eomparable, but from the point of view of accurate deseription and eeonomy of time, as well as ease of eomprehension, the pereentage of frequeney seems to be the most satisfaetory.

Table 1. Classification of Speeies Aeeording to Raunkiaer's Law and Compton's Determinations.

Species	Percentage of Frequency	Frequency	Abundance
Eastern Robin	88	a	17
Eastern Kingbird	88	a	15
Cedar Waxwing	84	a	1
Eastern Nighthawk	84	a	10
Eastern Chipping Sparrow	82	a	13
Eastern Song Sparrow	78	a	2
Red-eyed Towhee	78	a	4
Eastern Crow	76	a	3
Eastern Hermit Thrush	74	a	9
Spotted Sandpiper	72	a	6
Northern Flicker	72	a	14
Red-eyed Vireo	72	a	5
Eastern Whip-poor-will	70	a	12
Eastern Goldfinch	70	a	7
Brown Thrasher	68	c	26
Eastern Cowbird	60	c	24
Oven-bird	58	c	11
Eastern Belted Kingfisher	56	a	16
Eastern Vesper Sparrow	56	a	8
Eastern Wood Pewee	50	a	19
Northern Blue Jay	50	c	26
Slate-colored Junco	50	a	15
Caspian Tern	48	c	33
American Redstart	46	a	14
Black-capped Chickadee	44	c	21
Eastern Mourning Dove	42	r	46
Killdeer	40	c	23
Eastern Ruffed Grouse	40	a	20
Eastern Phoebe	40	c	43
Rough-winged Swallow	40	—	—
Eastern House Wren	40	c	30
Common Tern	34	r	46
Black-throated Green Warbler	34	c	29
Black and White Warbler	26	c	34
Black-billed Cuckoo	24	r	44
Chimney Swift	24	a	26
Least Flycatcher	24	r	45
Indigo Bunting	24	c	23
Barn Swallow	24	r	45
Bronzed Grackle	22	r	46
Eastern Winter Wren	22	c	23
Great Blue Heron	20	c	43
English Sparrow	20	c	20

Species	Percentage of Frequency	Frequency	Abundance
Eastern Meadowlark	18	r	38
Eastern Golden-crowned Kinglet	18	c	39
Eastern Red-wing	16	c	42
Eastern Purple Finch	16	c	39
Scarlet Tanager	16	c	36
American Merganser	14	—	—
Osprey	14	r	46
Prairie Horned Lark	14	r	43
Myrtle Warbler	14	r	46
Magnolia Warbler	14	—	—
Herring Gull	12	—	—
Ring-billed Gull	12	—	—
Northern Crested Flycatcher	12	r	47
Chestnut-sided Warbler	12	c	21
Red-breasted Nuthatch	12	r	46
Red-headed Woodpecker	10	c	42
Purple Martin	10	r	46
Veery	10	r	46
American Bittern	8	r	47
Marsh Hawk	8	c	42
Eastern Hairy Woodpecker	8	c	36
Northern Downy Woodpecker	8	a	25
Bobolink	8	r	43
White-throated Sparrow	8	a	18
Tree Swallow	8	c	28
Migrant Shrike	8	—	—
Mourning Warbler	8	—	—
Canada Warbler	8	r	43
Catbird	8	r	42
Brown Creeper	8	r	46
Wilson Snipe	6	—	—
Eastern Sparrow Hawk	6	r	45
Great Horned Owl	6	—	—
Yellow-bellied Sapsucker	6	a	20
Eastern Savannah Sparrow	6	r	45
Black-throated Blue Warbler	6	r	40
Blackburnian Warbler	6	r	44
Northern Pine Warbler	6	c	34
Olive-backed Thrush	6	r	41
Common Black Duck	4	—	—
Sharp-shinned Hawk	4	r	46
Eastern Goshawk	4	—	—
Olive-sided Flycatcher	4	r	46
Northern Pine Siskin	4	—	—
Clay-colored Sparrow	4	—	—
Northern Cliff Swallow	4	c	32
Bank Swallow	4	r	44
Eastern Yellow Warbler	4	r	46
Pied-billed Grebe	2	r	47
Piping Plover	2	—	—
Virginia Rail	2	r	46
Sora	2	—	—
Least Sandpiper	2	—	—
American Woodcock	2	—	—
Northern Red-shouldered Hawk	2	—	—
Southern Bald Eagle	2	r	43
Ruby-throated Hummingbird	2	c	42
Alder Flycatcher	2	—	—
Eastern Field Sparrow	2	r	47
Northern Parula Warbler	2	—	—

TABLE 2. Comparison of the Five Classes of Frequeney for Three Localities.

	Michigan		Kansas		California	
	Species	Ratio	Species	Ratio	Species	Ratio
A	62	.59	133	.68	111	.73
B	16	.15	32	.16	20	.13
C	11	.10	13	.07	7	.05
D	10	.09	6	.03	5	.03
E	5	.05	10	.05	8	.05

The five classes, A, B, C, D, E, include the species of frequeney of, respcctively, 1-20 per cent, 21-40 per cent, 41-60 per eent, 61-80 per cent, and 81-100 per cent. Each ratio rcpresents the relation between the number of species in cach group and the number of species recorded for that area. In general the distribution of the Michigan species among the elasses of frequency resembles that of the other two loealities. The differences probably result from restrietion of observations in the former to the summer season and from the small number of days reprcsentcd.

I anticipate that further tcsts of this mcthod in other loealities will demonstratc its usefulness as a device for analyzing the eomposition of the avifauna. Everywhere, it is to be expected, many more species will prove to be of low frequenee than of high frequence. However, these species of low frequcnce may bc among the most important in the make-up of the wild animal population. They are likely to be ones of great interest to their human assoeiates. Birds of prey, large species, and the smaller raritics, even when they come in the lowest frequency elass, arc the oncs which contributc most to the attraetivcness of wilderness areas and the outdoors in general for thc pcrson who watches birds. It is the natural proportions bctwcen species, as revealcd by analyses of populations, that we should strive to maintain in our eonservational activities. This original composition of an avifauna is so eomplex that we can searcely hopc to understand or to dcscribe it without the aid of somc simplc deviee such as the one based on thc Raunkiaer law. It has been demonstrated over and over that an important result of the ordinary kind of human oceupation of land is to remove the species of low frequenee or to lowcr thcir frequency of occurrcnec and to increase the frequeney of occurrencc of a few spccies, usually oncs already common.

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